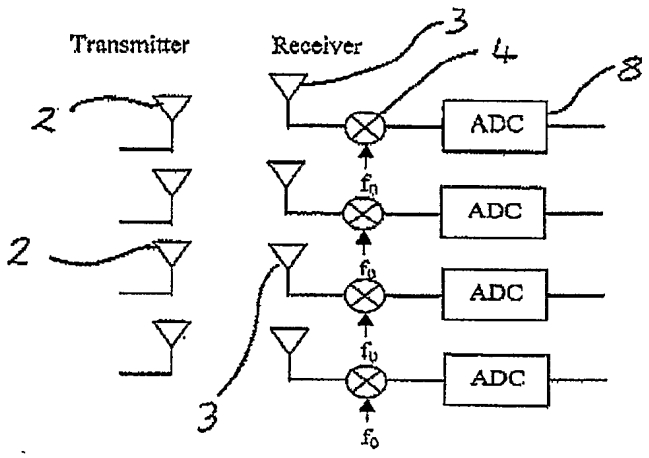


Fig. 1

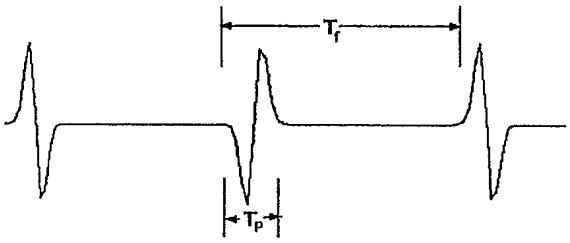


**Fig. 2(a)**

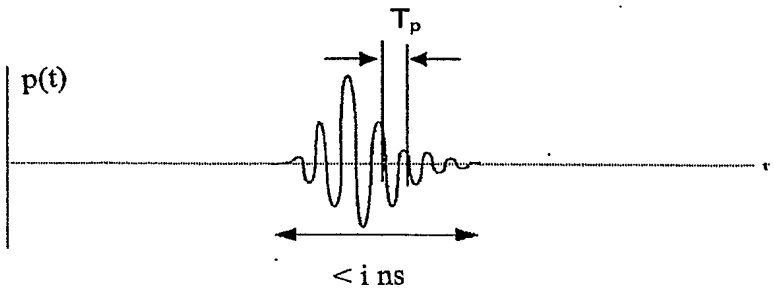


**Fig. 2(b)**

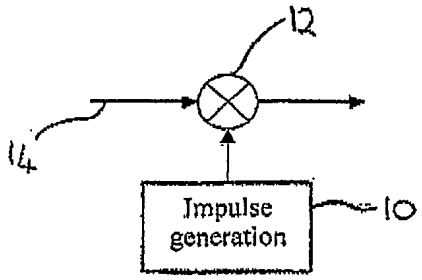
12
14
Impulse generation
10

Fig. 3(a)

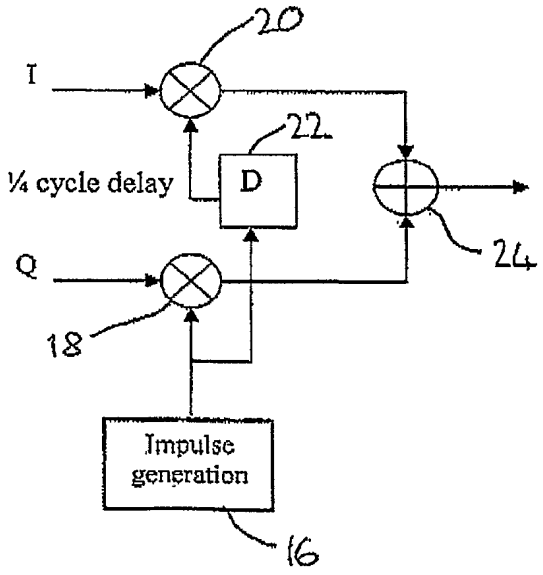
20
I
22
¼ cycle delay
D
24
Q
18
Impulse generation
16

Fig. 3(b)

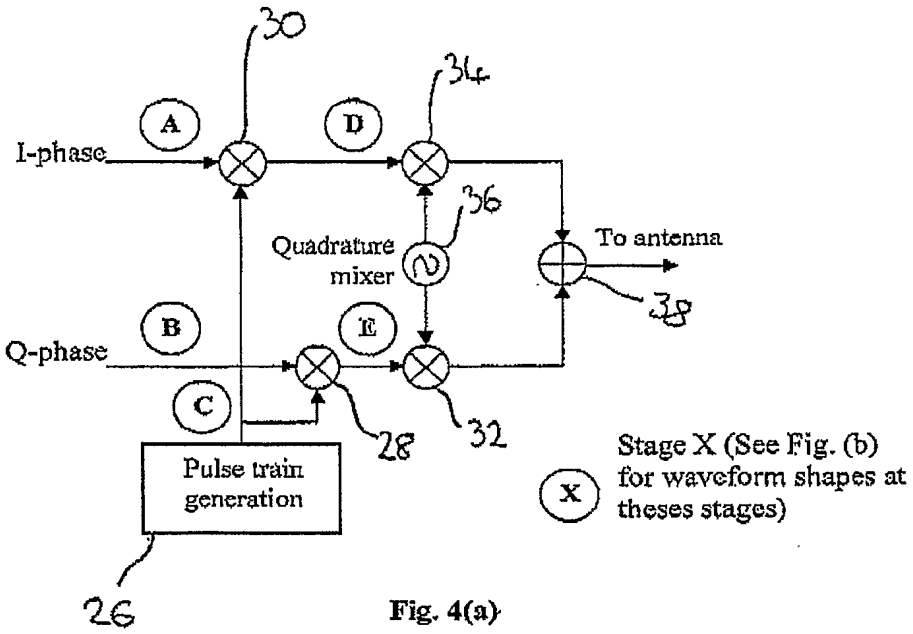
30
34
A
D
I-phase
36
Quadrature
mixer
To antenna
38
B
E
Q-phase
C
28
32
Pulse train
generation
X
Stage X (See Fig. (b)
for waveform shapes at
theses stages)
26

Fig. 4(a)

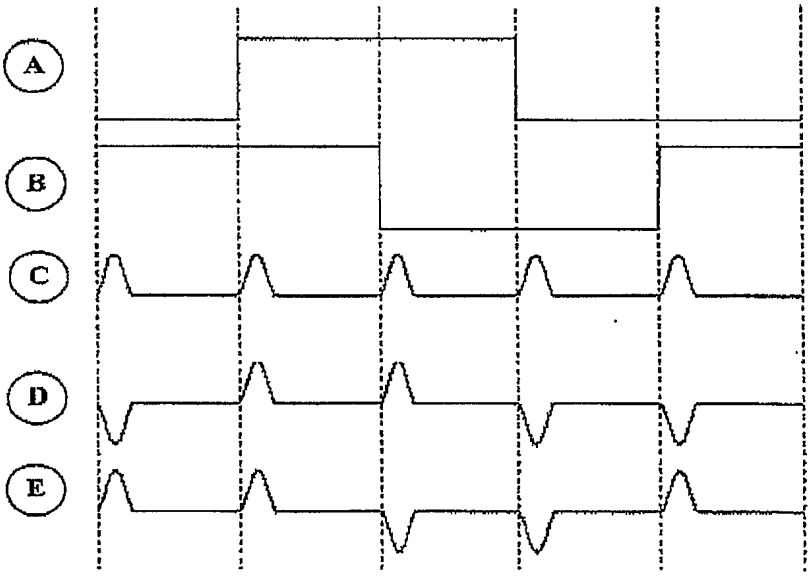
A
B
C
D
E

Fig. 4(b)

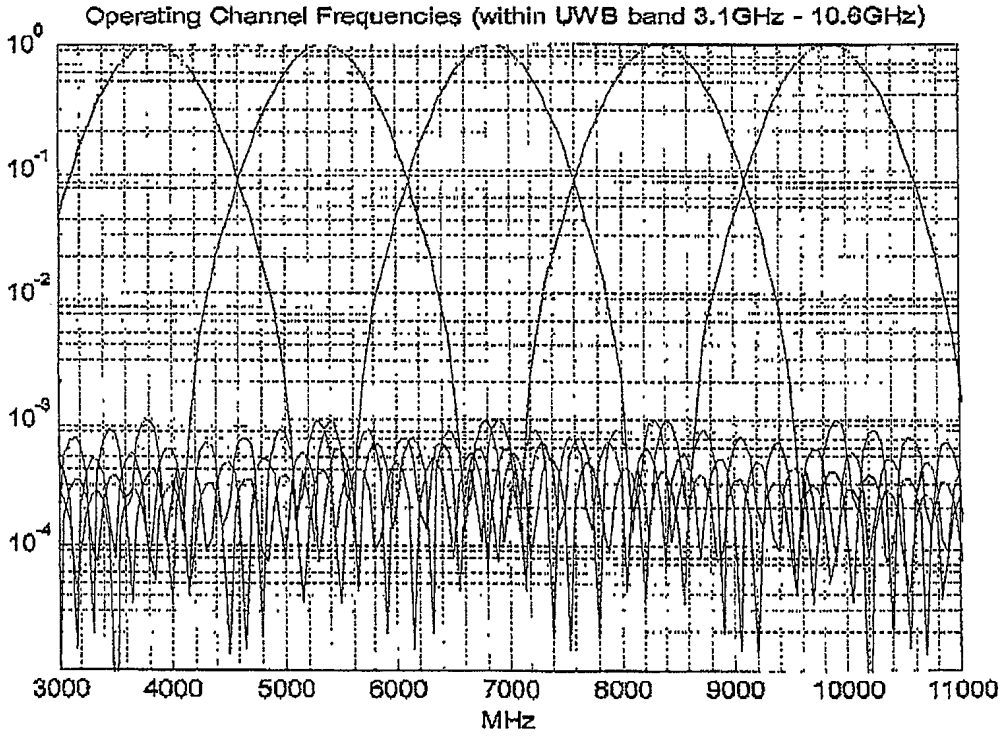
Operating Channel Frequencies (within UWB band 3.1GHz - 10.6GHz)
10^0
10^-1
10^-2
10^-3
10^-4
3000
4000
5000
6000
7000
8000
9000
10000
11000
MHz

Fig. 5

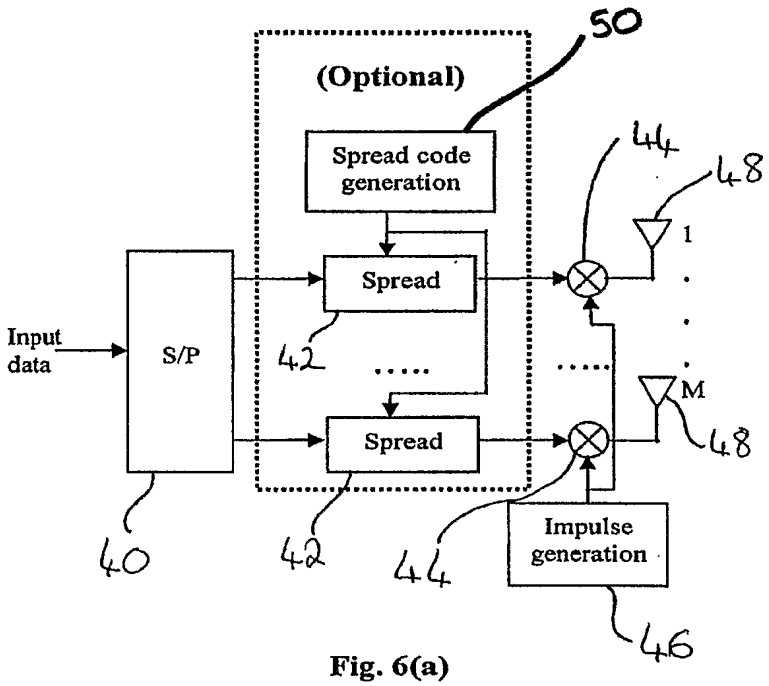
(Optional)
50
Spread code generation
44
48
1
Spread
Input data
S/P
42
.....
M
Spread
48
40
42
44
Impulse generation
46

Fig. 6(a)

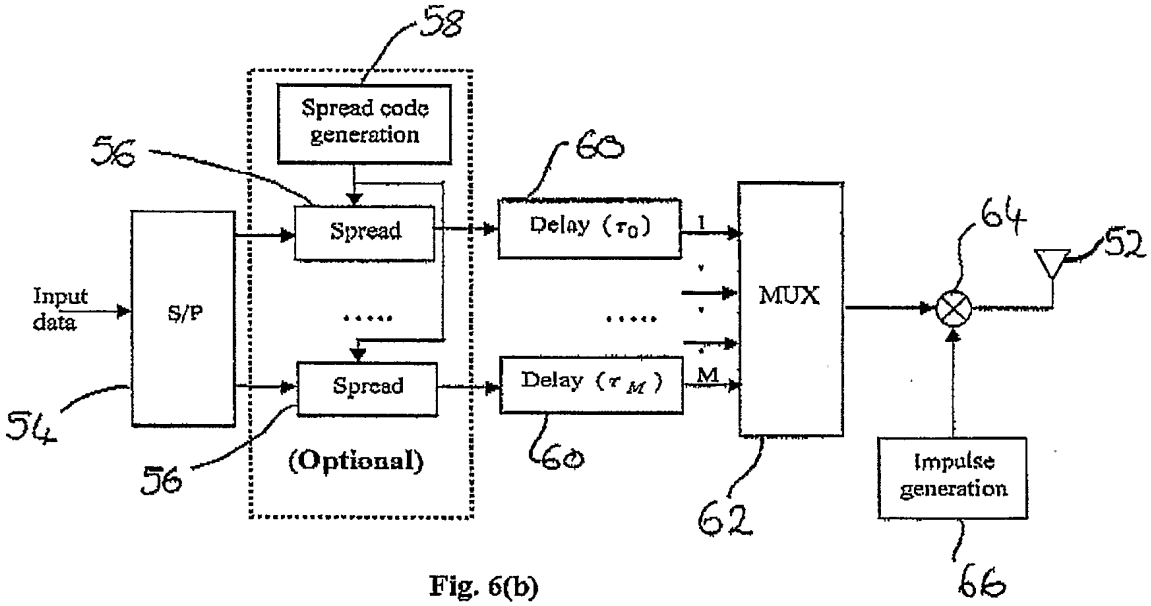
58
Spread code generation
56
Spread
Spread
(Optional)
Input data
S/P
54
56
60
Delay ($\tau_0$)
Delay ($\tau_M$)
1
M
MUX
62
64
52
Impulse generation
66

Fig. 6(b)

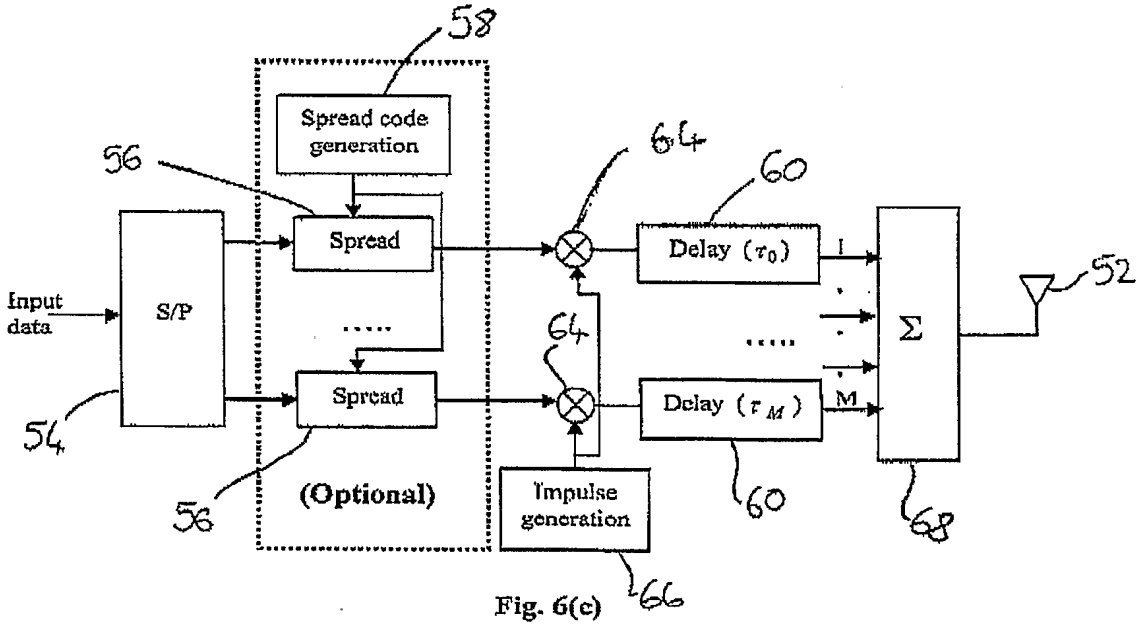
58
Spread code generation
56
Spread
Spread
(Optional)
Input data
S/P
54
56
64
60
Delay ($\tau_0$)
Delay ($\tau_M$)
1
M
Σ
52
Impulse generation
66
68

Fig. 6(c)

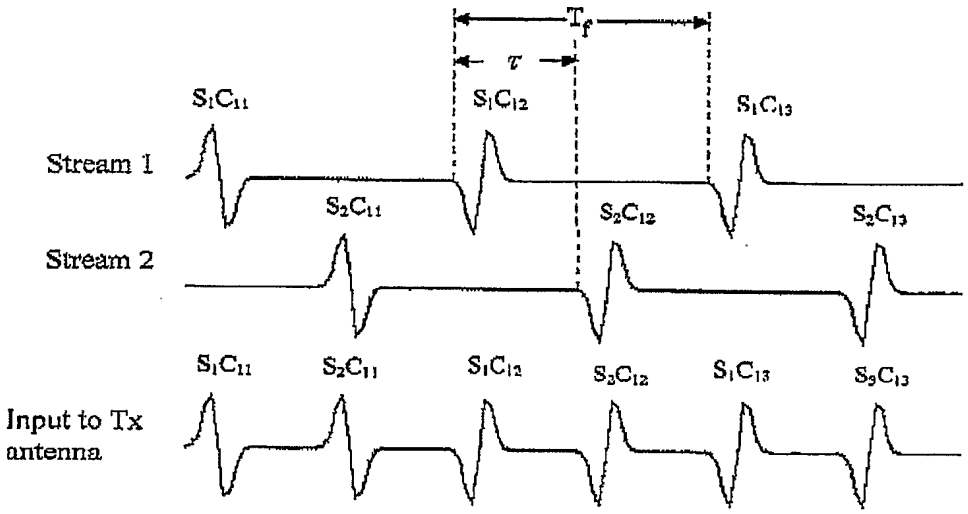
$T_f$
$\tau$
$S_1C_{11}$
$S_1C_{12}$
$S_1C_{13}$
Stream 1
$S_2C_{11}$
$S_2C_{12}$
$S_2C_{13}$
Stream 2
$S_1C_{11}$
$S_2C_{11}$
$S_1C_{12}$
$S_2C_{12}$
$S_1C_{13}$
$S_2C_{13}$
Input to Tx antenna

Fig. 7

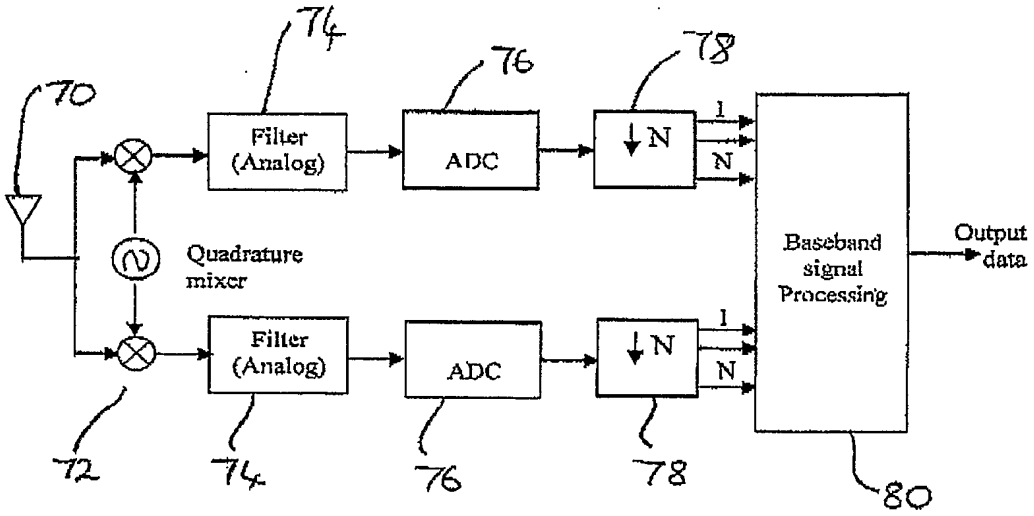
70
74
76
78
Filter (Analog)
ADC
↓N
1
N
Quadrature mixer
Baseband signal Processing
Output data
Filter (Analog)
ADC
↓N
1
N
72
74
76
78
80

Fig. 8

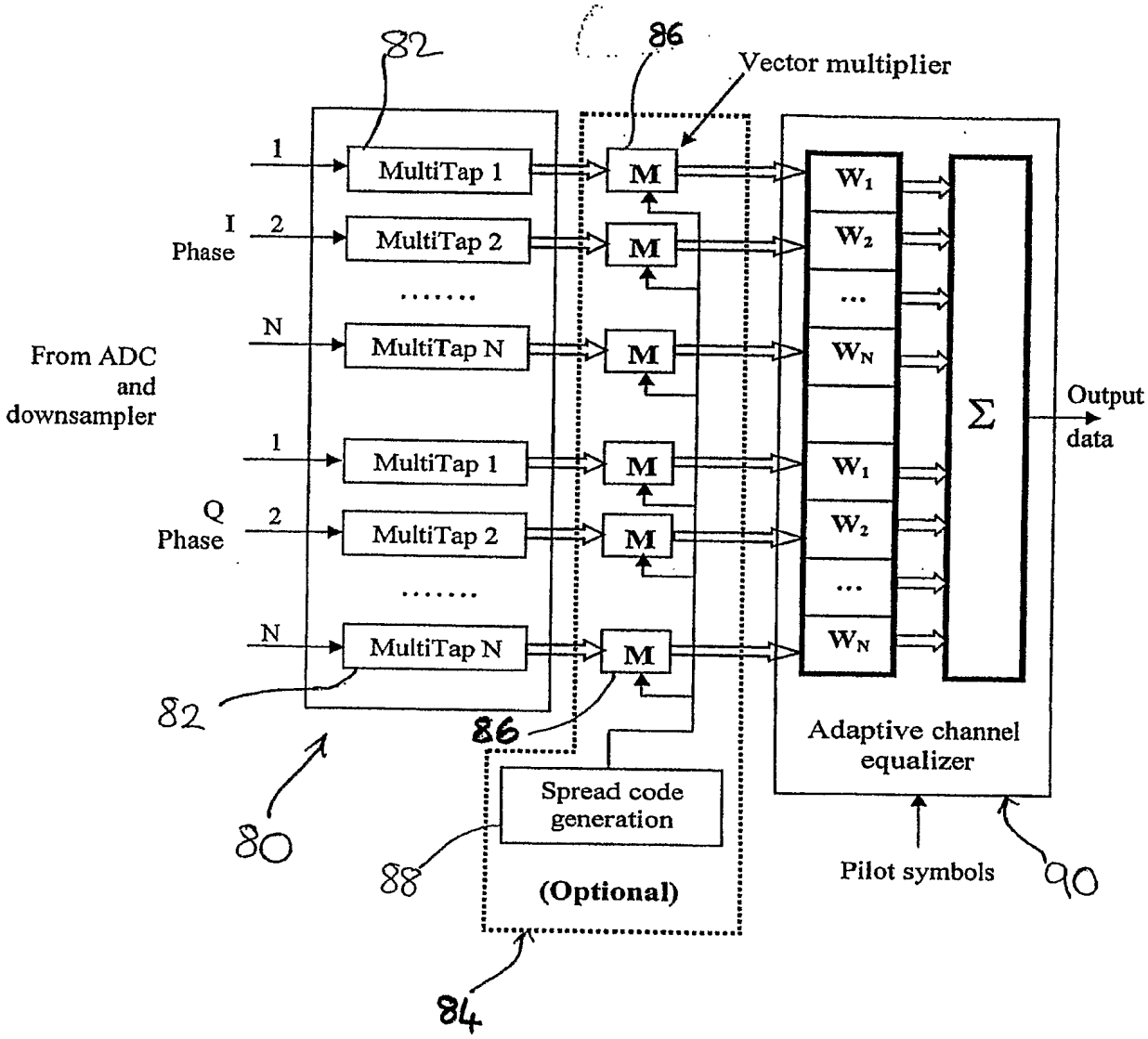
82
86
Vector multiplier
1
MultiTap 1
M
W1
I
Phase
2
MultiTap 2
M
W2
...
N
MultiTap N
M
WN
From ADC
and
downsampler
Σ
Output
data
1
MultiTap 1
M
W1
Q
Phase
2
MultiTap 2
M
W2
...
N
MultiTap N
M
WN
82
86
Adaptive channel
equalizer
Spread code
generation
80
88
(Optional)
Pilot symbols
90
84

Fig. 9(a)

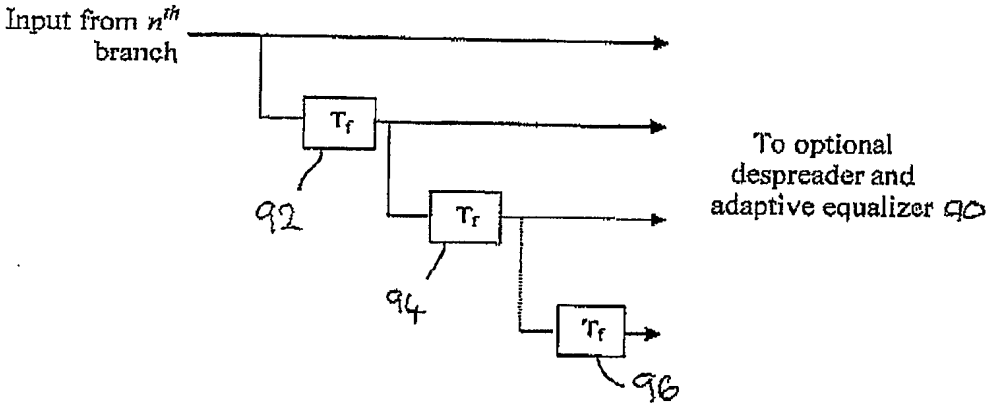
Input from $n^{th}$ branch
$T_f$
$T_f$
$T_f$
92
94
96
To optional despreader and adaptive equalizer 90

Fig. 9(b)

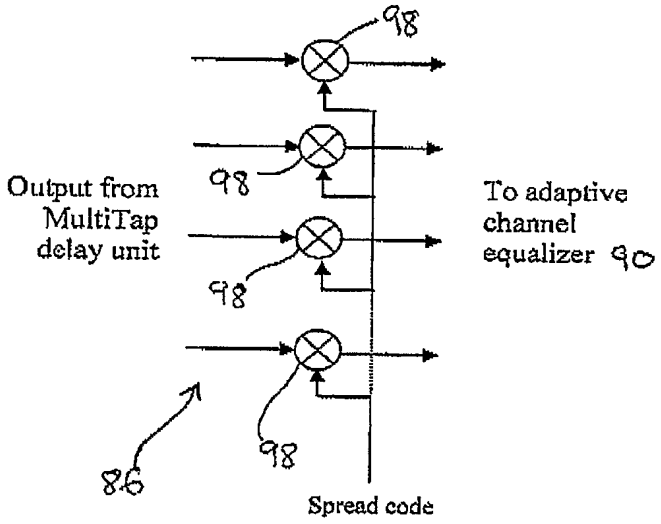
98
98
98
98
86
Output from MultiTap delay unit
To adaptive channel equalizer 90
Spread code

Fig. 9(c)

| Target Channel Characteristics[5] | CM 1[1] | CM 2[2] | CM 3[3] | CM 4[4] |
|---|---|---|---|---|
| Mean excess delay (nsec) ($\tau_m$) | 5.05 | 10.38 | 14.18 | |
| RMS delay (nsec) ($\tau_{rms}$) | 5.28 | 8.03 | 14.28 | 25 |
| Number of mulitpaths within 10 dB | | | 35 | |
| No of multipaths within 85% of energy | 24 | 36.1 | 61.54 | |
| **Model Parameters** | | | | |
| Cluster arrival rate, $\Lambda$ (1/nsec) | 0.0233 | 0.4 | 0.0667 | 0.0667 |
| Ray arrival rate, $\lambda$ (1/nsec) | 2.5 | 0.5 | 2.1 | 2.1 |
| Cluster decay factor, $\Gamma$ | 7.1 | 5.5 | 14.00 | 24.00 |
| Ray decay factor, $\gamma$ | 4.3 | 6.7 | 7.9 | 12 |
| Standard deviation of cluster log-normal fading term, $\sigma_1$ (dB) | 3.3941 | 3.3941 | 3.3941 | 3.3941 |
| Standard deviation of ray log-normal fading term, $\sigma_2$ (dB) | 3.3941 | 3.3941 | 3.3941 | 3.3941 |
| Standard deviation of log-normal shadowing for all, $\sigma_x$ (dB) | 3 | 3 | 3 | 3 |
| **Model Characteristics[5]** | | | | |
| Mean excess delay (nsec) ($\tau_m$) | 4.9 | 9.4 | 13.8 | 26.8 |
| RMS delay (nsec) ($\tau_{rms}$) | 5 | 8 | 14 | 26 |
| Number of multipaths within 10 dB | 13.3 | 18.2 | 25.3 | 41.4 |
| No of multipaths within 85% of energy | 21.4 | 37.2 | 62.7 | 122.8 |
| Channel energy mean (dB) | -0.5 | 0.1 | 0.2 | 0.1 |
| Channel energy std (dB) | 2.9 | 3.3 | 3.4 | 3.2 |

[1] This model is based on Line Of Sight (LOS) (0-4 meter) channel measurements.
[2] This model is based on Non-Line Of Sight (NLOS) (0-4meter) channel measurements.
[3] This model is based on NLOS (4-10 meter) channel measurements.
[4] This model was generated to fit a 25 nanoseconds RMS delay spread to represent an extreme NLOS multipath channel.
[5] These characteristics are based upon a 167 picoseconds sampling time.
(More details of these channel models are described in Channel Modeling Sub-Committee Final Report of IEEE P802.15 Working Group for Wireless Personal Area Networks, *Document No: IEEE P802.15-02/368r5-SG3a*, December 2002.

Fig. 10

| Parameters | Values | | |
|---|---|---|---|
| Data modulation (Dm) | QPSK | | |
| No of Transmit data streams (Nx) | 2 | | |
| LO Frequency | 4 GHz | | |
| ADC Sampling rate (Fs) | 2 GHz | | |
| No of bits/ADC | Floating point and one-bit ADC | | |
| Oversampling factor (Os) | 32 | 16 | 16 |
| No of Delay taps | 2 | 4 | 2 |
| Pulse rate (Chip rate) (Pr = (Fs/Os)*Nx) | 125 Mpps | 250 Mpps | 250 Mpps |
| Processing gain (G) | 4 (Pilot), 1 (Data) | | |
| Channel coding (R) | ¼ | | |
| Data Rate (Dr = (Pr/G)*R*Dm) | 62.5 Mbps | 125 Mbps | 125 Mbps |
| Channel Equalization | RLS Equalizer | | |
| Channel Models used | CM1 LOS (0-4M) and CM3 NOLS (4-10M) | | |

Fig. 11

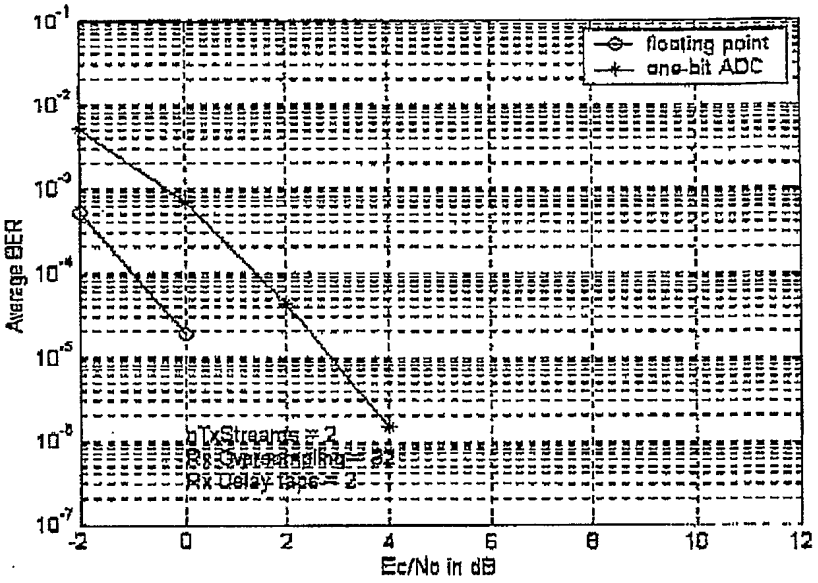


Fig. 12(a)

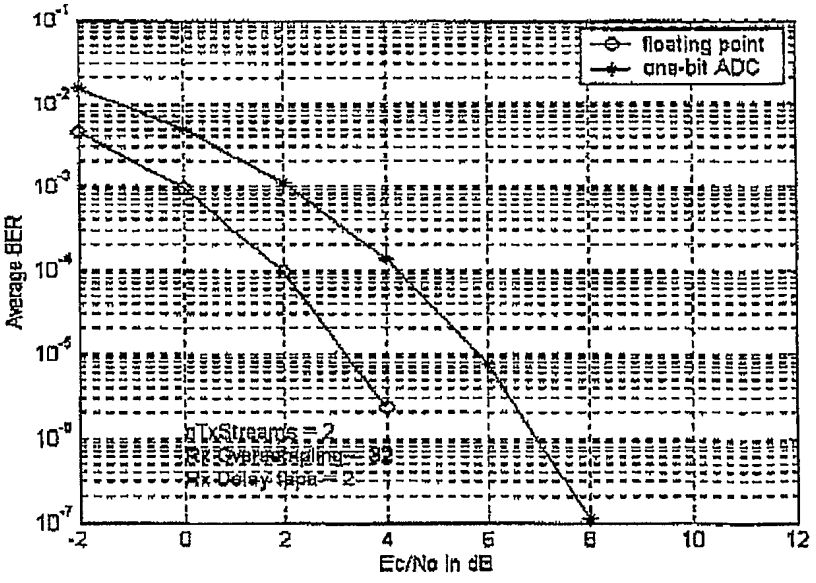


Fig. 12(b)

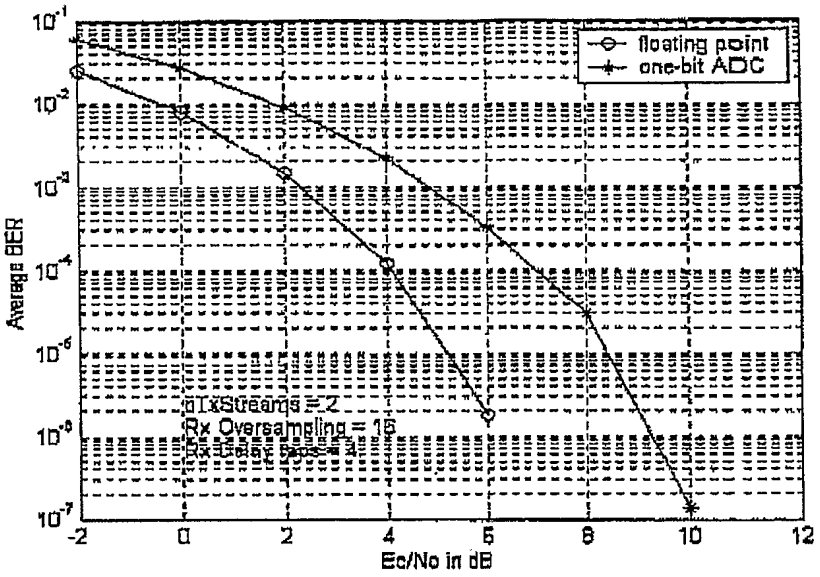


Fig. 13(a)

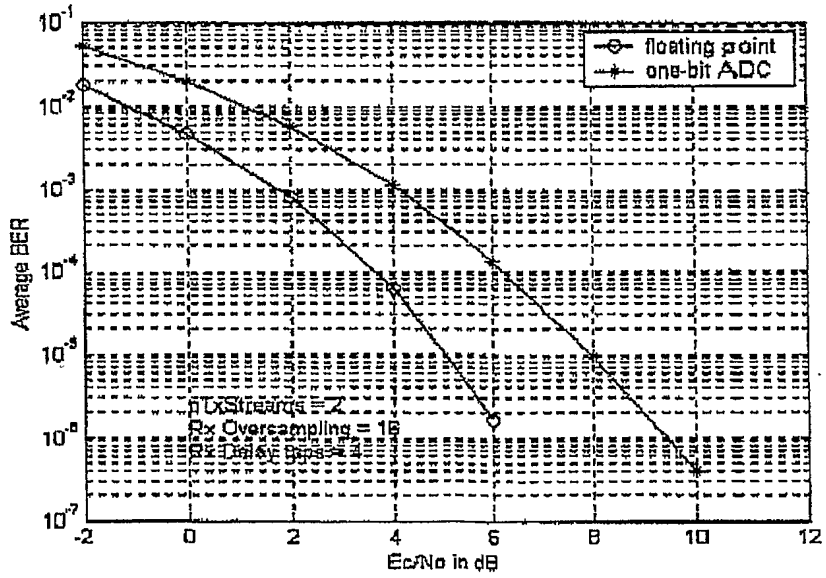


Fig. 13(b)

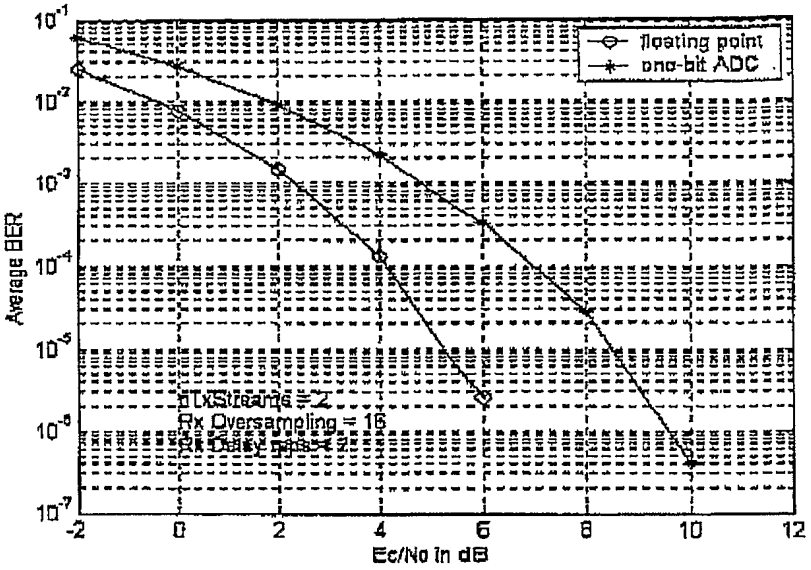


Fig. 14(a)

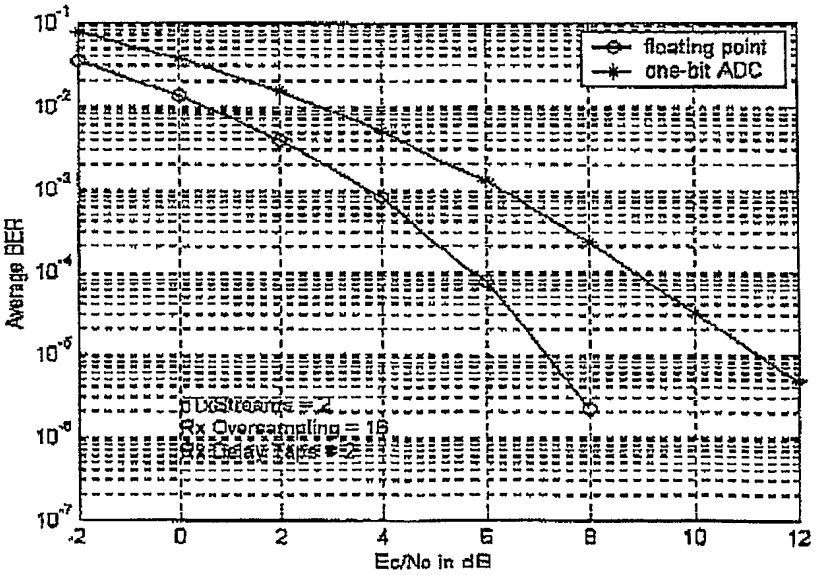


Fig. 14(b)

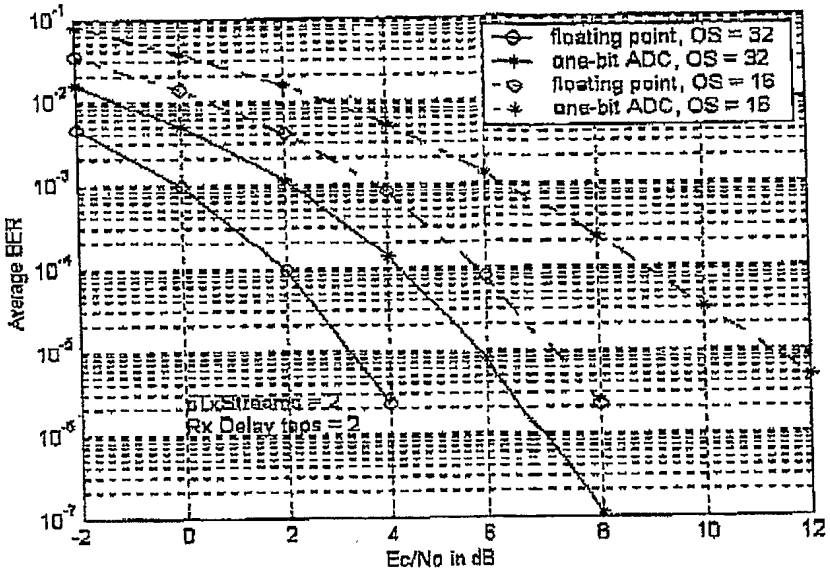


Fig. 15(a)

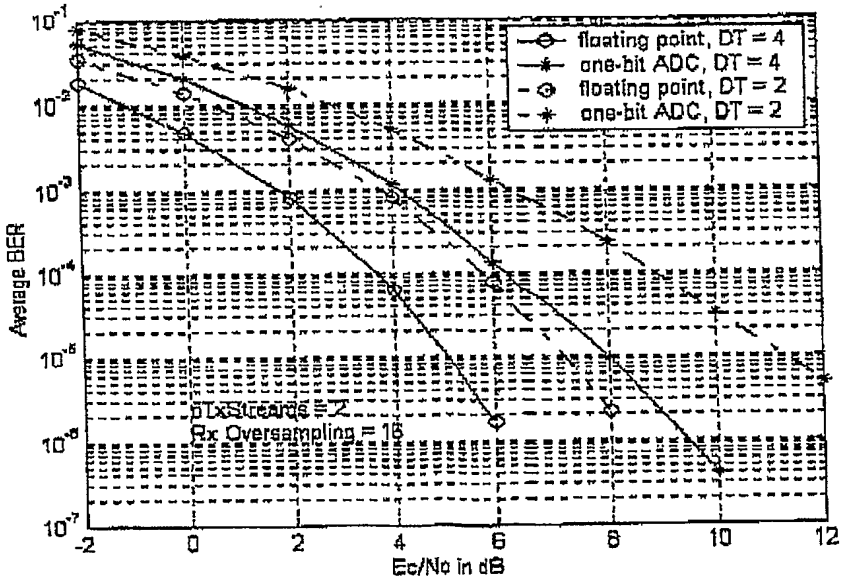


Fig. 15(b)